OILFIELD INTERNAL CORROSION INHIBITOR FUNDAMENTALS

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OVERVIEW

• Corrosion Inhibitor Classification
• Corrosion Inhibitor Formulation
• Corrosion Inhibitor Application
• Batch Treatment
• Continuous Treatment
• Pipeline Treatment
• Corrosion Inhibitor Considerations
• Conclusions
CORROSION INHIBITOR CLASSIFICATION

• Film Forming
  • Protective diffusion barrier
  • Steel wettability hydrophobic not hydrophilic
  • Effective for CO₂ and H₂S corrosion

• Oil Soluble
  • Lower water cut
  • Stratified or turbulent flow / high velocity

• Water Soluble
  • Typically used with higher water cut
  • Stratified or turbulent flow

• Oil Soluble / Water Dispersible
  • Can be used with all water cuts
  • Partitioning
CORROSION INHIBITOR FORMULATION

- Surface active agents
  - Active Ingredient
    - Imidazoline
    - Amides
    - Quaternary Amines
    - Dimer / Trimer Acids
  - Solvents
    - Glycol, alcohol, EGMBE, water, aromatic / aliphatic solvents
  - Surfactants
    - Nonylphenol, ethoxylates, phosphate esters
CORROSION INHIBITOR FORMULATION

- Imidazolines/Amides
  - Batch or Continuous
  - Wide range of applications
  - Effective in gas streams
  - High temperature and velocity tolerant
  - Environmentally unfriendly – Imidazolines
  - Environmentally friendly – Amides
CORROSION INHIBITOR FORMULATION

- Amines
  - Quaternary Amines
    - Effective in sweet and sour conditions
    - Effective in high velocity conditions
    - Environmentally unfriendly
    - Aids in partial water phase partitioning

\[ \text{Amine} \]

\[ \text{H}_3\text{C} \]

\[ \text{NH}_2 \]

\[ \text{Amine} \]
CORROSION INHIBITOR FORMULATION

• Dimer / Trimer Acids
  • Batch applications
  • Oil soluble
  • Effective in sweet and sour conditions
• Synergist with imidazoline
• Environmentally friendly
CORROSION INHIBITOR APPLICATION

- Downhole
  - Batch via squeeze
  - Batch via annulus (Shot truck / Flush)
  - Continuous via gas lift / capillary string

- Production Multiphase
  - Batch via cleaning pigs
  - Continuous injection via atomizer or quill
CORROSION INHIBITOR CONSIDERATIONS

- Stability
  - Thermal
  - Foaming
  - Gunking
  - Compatibility - (Metal, Elastomer, Fluids)
- Solubility / Dispersibility
  - Partitioning
- Corrosivity
  - Metallurgy
  - Injection methods
- Application Constraints
  - Temperature
  - Velocity
BATCH TREATMENT

• Advantages
  • Excellent initial coating on pipeline or production tubing
  • Cost effective
  • Infrequent treatments needed to refresh 3 mil coverage
  • Application between cleaning pigs

• Disadvantages
  • Requires more manpower
  • High initial concentration required
  • Half life of film will vary as production progresses
  • Cannot stabilize emulsions or film tenacity suffers
BATCH TREATMENT

• Pipelines
  • Pig pipeline prior to application of film
  • Pig removes biofilms for more steel surface area
  • Typical initial calculation is 3 mil thick film
    • 1 mil thickness = 0.86 gallons per diameter inch per mile
  • MPY measurements from coupons every 30 days
  • Amine residuals to verify inhibitor concentrations
CONTINUOUS TREATMENT

• Oil Pipelines
  • ~10-200 ppm/v based on total fluids
  • Water Soluble – Stratified Flow / High Water Cut
  • Oil Soluble / Water Dispersible – Emulsions
  • Injected using quill near wellhead

• Gas Pipelines
  • ~2500 ppm/v (derived from BS&W)
  • ~2 pints per 1MMSCF
  • Injected using atomizer near wellhead
  • Neutralized product
CONTINUOUS TREATMENT

• Advantages
  • Effective dispersion
  • Rates can be varied with no initial loss
  • No shutdown required
  • Multifunctional methods

• Disadvantages
  • Equipment costs (Capillary String, Gas Lift, Quill / Atomizer)
CONCLUSIONS

• Corrosion inhibitors are a cost effective measure for production
• Water Soluble, Oil Soluble, Oil Soluble / Water Dispersible
• Complex formulations for specificity
• Extend the service life of lower grade steels (C1018)
• Myriad of potential applications for tailored protection
• Effective in sweet and sour environments